



## **CSTools: a new R package for the calibration, combination, downscaling and analysis of seasonal forecasts**

Nuria Perez-Zanon (1), Louis-Philippe Caron (1), M. Carmen Alvarez-Castro (2), Lauriane Batté (3), Susanna Corti (4), Marta Dominguez (5), Federico Fabiano (4), Silvio Gualdi (2), Jost von Hardenberg (4), Llorenç Lledó (1), Nicolau Manubens (1), Paola Marson (3), Stefano Materia (1), Eroteida Sánchez (5), Bert Van Schaeybroeck (6), Veronica Torralba (1), Silvia Terzago (4), Deborah Verfaillie (1), Danila Volpi (1,3)

(1) Barcelona Supercomputing Center, Earth Sciences, L'Hospitalet de Llobregat, Spain (nuria.perez@bsc.es), (2) Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC), Bologna, Italy, (3) MeteoFrance/DCSC/AVH, France, (4) Institute of Atmospheric Sciences and Climate, National Research Council of Italy, Corso Fiume 4, Turin, Italy (CNR), (5) Delegación territorial (DT) Cantabria, Agencia Estatal de Meteorología (AEMET), (6) Royal Meteorological Institute of Belgium

The availability of climate data has never been larger, as evidenced by the development of the Copernicus Climate Change Service. However, availability of climate data does not automatically translate into usability and sophisticated post-processing is often required to turn these climate data into user-relevant climate information allowing them to develop and implement strategies of adaptation to climate variability and to trigger decisions.

Developed under the umbrella of the ERA4CS Medscope project by multiple European partners, here we present a R package currently in development, which aims to provide tools to exploit dynamical seasonal forecasts such as to provide information relevant to public and private stakeholders at the seasonal timescale. This toolbox, called CSTools (short for Climate Service Tools), contains process-based methods for forecast calibration, bias correction, statistical and stochastic downscaling, optimal forecast combination and multivariate verification, as well as basic and advanced tools to obtain tailored products.

In addition to presenting some of the tools that are contained in the package, we also present a short overview of the development strategy adopted for this toolbox. The latter relies on a version controlling system established such as to allow scientists and developers to work within a common framework using a platform where they can exchange with other developer, test the various functionalities and discuss issues arising from the work, amongst other things. Furthermore, we will also present some vignettes, which are one of the mechanism that allows users to understand and visualize the capabilities of CSTools. For instance, CSTools contains a step by step vignette showing how to use and visualize the output of MultivarRMSE, which gives an indication of the forecast performance (RMSE) for multiple variables simultaneously.

While the extensive community of R users offers the opportunity of merging climate forecaster experts with final users, CSTools can also be used by other communities, such as Python users through the interface rpy. Finally, the planned publication of this package on CRAN (the Comprehensive R Archive Network) will make it easily accessible to interested users and ensures its proper functioning on different operational systems.